Inyo National Forest

Eastern Sierra Fire Restoration and Maintenance Project

Prescribed burning on the Inyo National Forest in 2019. Photo by Jeffrey Karl, USFS

INTRODUCTION

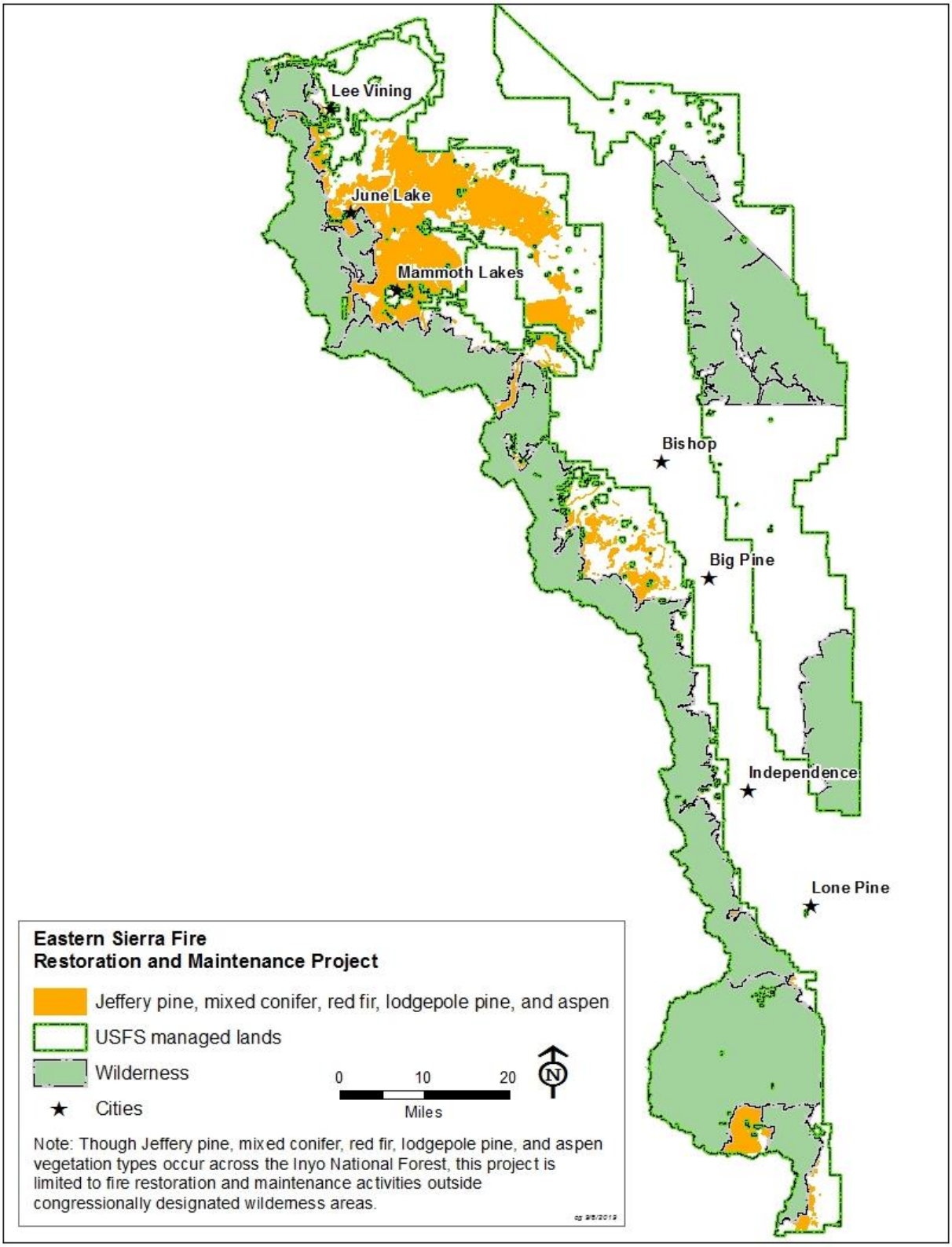
Fire is a dominant ecosystem process in the Sierra Nevada that has shaped ecosystem structure, function, and composition for thousands of years. For more than a century, fire exclusion across the Inyo National Forest has contributed to increased density in coniferous forests with naturally frequent to moderate fire return intervals. These conditions are conducive to large wildfires. Aspen life cycles are also closely tied to fire and 40 percent of stands are at moderate to high risk of loss on the Inyo National Forest due to conifer ingrowth and lack of hormonal suckering response and seedling establishment associated with fire disturbance. Restoring and maintaining the process of fire is needed in coniferous and aspen vegetation types that were historically exposed to frequent to moderately frequent fire. The Inyo National Forest proposes to increase the pace and scale of prescribed burning to reduce damaging wildfires which impact ecosystem health, watersheds and public safety. Increasing the scale of prescribed burning will decrease the adverse effects of destructive wildfires and restore our forests.

The Inyo National Forest **proposes to use prescribed fire in the eastern Sierra Nevada outside of designated wilderness in conifer and aspen vegetation types in order to achieve and maintain desired conditions where fire historically occurred at high to moderate frequencies.** The forest types included are Jeffrey pine, mixed conifer, aspen, and some red fir and lodgepole pine stands (see Appendix A). This project will authorize using prescribed fire to restore and maintain the appropriate fire return interval. After the first entry with fire, the Forest will use prescribed fire to maintain the appropriate fire return intervals in each forest type. According to the current best available science, maintenance of the fire regime would result in approximately 140,000 acres of fire in the project area per decade (See Appendix A, Table A2). The current analysis will provide a range of opportunities for prescribed fire that can be prioritized and scheduled in any given year based on existing fuels, environmental conditions, and available resources. Prescribed burning will be consistent with the Forest Plan and adhere to established guidelines, law, regulations, and policy.

Proposed Project Location

The project area is located within the Inyo National Forest boundary on NFS lands of the eastern Sierra Nevada in areas supporting Jeffrey pine, mixed conifer, red fir, lodgepole pine, and aspen vegetation types, excluding designated wilderness (Figure 1).

Figure 1. Map of general project area.



NEED FOR THE PROPOSAL

Fire has been excluded from much of the Inyo National Forest to protect life, property, and natural resources since the1800s. The combination of fire suppression, past timber management practices, and historic levels of livestock grazing have resulted in denser and more homogeneous Jeffery pine and mixed conifer forests over much of the Inyo National Forest (Safford and Stevens 2017). Current conditions in these ecosystems are conducive to rapid fire growth with uncharacteristically large areas (patches) of high vegetative mortality (e.g. 2016 Owen's River Fire, 2016 Clark Fire; Meyers et al. 2018). This fire effect is increasingly common in the western United States, resulting in slow unassisted forest regeneration or complete tree regeneration failure due to limited natural seeding sources within large patches of fire killed trees (Welch et al. 2016, Shive et al. 2018). In the absence of frequent fire, these forests are more susceptible to mortality events associated with long-term drought, inter-tree competition, insect and disease, and climate change. Red fir and lodgepole pine dominated forests historically experienced a longer fire return interval than that of Jeffery pine and mixed conifer ecosystems (Meyer and North 2019) and are less departed from historic conditions than the Jeffrey pine forests; however, especially in the more productive locations, these stands are also showing the effects of fire suppression. Fire occurrence is less frequent in aspen vegetation types as well. Historic fire frequency and severity must be restored and maintained. The Inyo National Forest has been implementing prescribed fire in individual stands, but there is a need to reintroduce fire at larger scale to achieve desired conditions across fire dependent ecosystems.

Purpose and Need for the Project

The overall purpose of the proposed action is to restore natural fire regimes by reintroducing fire in forest ecosystems with a high to moderate fire frequency. By applying prescribed fire, critical ecological processes will be restored. Returning and keeping these vegetation types within their natural range of variability will improve forest health, protect watershed quality, enhance understory vegetation diversity and wildlife habitat, foster and protect old forests, reduce negative effects to air quality during wildfires, and reduce the threat of severe wildfire effects on adjacent communities.

There is a need to move Jeffery pine, mixed conifer, red fir, lodgepole pine, and aspen forest vegetation types on the Inyo National Forest toward desired conditions for terrestrial ecosystems and vegetation described in the Inyo National Forest Land Resource Management Plan (USDA 2019).

Current vertical and horizontal fuel profiles in forest types are conducive to unnaturally large patches of high severity fire. Vertical heterogeneity with multiple age classes is desired, including an increase in the proportion of old forest (large diameter trees) and early seral age classes.

Current conditions pose a threat of large wildfire occurrence with impacts to the people who use and live in and around Inyo National Forest managed lands, as well as the ecological processes associated with these natural systems. This project will reduce tree densities and increase landscape age class diversity, resulting in conditions less conducive to high severity wildfire, improved residual forest health, protect watersheds, and improve habitat diversity.

Lack of fire in aspen is a major factor associated with significant risk to this vegetation type across the Forest. Lack of frequent and severe fire in aspen has led to conifer encroachment

overtopping above ground aspen. Aspen is shade intolerant and primarily reproduces through suckering following hormonal response triggered by disturbance that kills the bulk of the canopy. Current competition with encroaching conifers for light and water resources has compromised aspen extent, connectivity, and clone vigor. Applying prescribed fire to aspen stands is needed to reduce conifer competition, trigger hormonal suckering response, increase seedling establishment, and reduce the risk of aspen loss.

Prescribed fire must be used for this project due to the logistical, environmental and land designation constraints of the Forest. The Inyo National Forest is located in a remote portion of California with no nearby timber mills or biomass facilities to process wood products. Steep, rocky slopes over a vast portion of the Inyo are not compatible with economically viable timber extraction (e.g., ground based logging). There is a small fuelwood program that cuts timber across 200 – 400 acres annually which is inadequate for restoring forest structure at the landscape level. Much of the Inyo National Forest is not accessible for mechanical treatment due to topography, road locations, and restrictions such as designated wilderness or Inventoried Roadless areas, within which mechanized equipment is largely prohibited. In addition to these constraints, current appropriated budgets limit the amount of mechanical fuels reduction which can occur. Due to these challenges and the many beneficial effects associated with fire in forest ecosystems, prescribed fire is the most efficient method to restore fire adapted ecosystems on the Inyo National Forest at the landscape level.

PROPOSED ACTION

To restore and maintain the process of fire, the Inyo National Forest is proposing to use prescribed fire (under burning and pile burning) in frequent and moderate fire return interval forests in the Sierra Nevada and Glass Mountains. Management strategies suggested by researchers (North et al. 2009, North 2012) emphasize the use of prescribed fire as a fuel treatment and management tool for restoring natural processes. Forests adapted to high to moderate frequency fire benefit from fire exposure because fire creates and maintains forest structure, reduces ladder fuels, fosters age class and habitat diversity, stimulates natural regeneration, and sustains landscape characteristics similar to historic forest conditions.

This proposed project will analyze the potential for prescribed fire on all acres of National Forest System Lands within the eastern Sierra Nevada and Glass Mountains, dominated by Jeffery pine, mixed conifer, red fir, lodgepole pine, and aspen forest, except for those within designated wilderness.

Where fire control lines are lacking (e.g. roads, rock outcrops, trails, natural barriers), firelines will be constructed as necessary to limit fire spread. In areas where departure from natural fire regimes has resulted in excessive fuel loading and/or dense stand structures where fire behavior might exceed acceptable thresholds, some pretreatment may be done including hand thinning, limbing and/or targeted mowing. Design features and an implementation plan will be developed during project analysis to protect sensitive natural and cultural resources from undesirable effects. Burn plans will incorporate design features to ensure best management practices and other resource protection measures are carried out during project implementation. The following sections describe how prescribed fire will be used to achieve project objectives in more detail.

Prescribed Fire

The Forest will conduct prescribed burning at the appropriate fire return interval. Burning may occur anywhere within up to 200,000 acres of National Forest System Land, annual acres burned will depend upon resources and environmental conditions. Once landscapes have been restored with a first entry of fire, maintenance prescribed burns will occur. The current best available science suggests the use of approximately 140,000 acres burned per decade across the whole project area (Appendix A). Annual area burned will be variable and will depend on weather and other resource conditions. The project is being designed to provide a range of prescribed fire opportunities that can be prioritized and scheduled as necessary in any given year, allowing for flexibility in implementation. Flexibility is needed to implement prescribed fire where it is most needed and most feasible to implement, such as locations which will serve as anchor points for additional treatments, and buffers to protect highly valued resources and assets from future wildland fires.

Individual prescribed burns will be at a scale that mimics the natural fire size in the target forest types and to provide the desired mosaic desired conditions from the Inyo National Forest Plan (2019). Each burn area is anticipated to have different fire return frequencies dependent on vegetation type (such as two to three fire entries in a 15 to 20 year period for Jeffrey pine forests). All prescribed fire will occur in the project area according to applicable design features and under appropriate burning conditions to move treatment areas toward the desired conditions applicable to the relevant vegetation type for the area (Appendix A). The actual amount of annual burning is dependent on a variety of factors including, but not limited to, funding, weather conditions, resource protection measures, resources available to accomplish treatments, and regional wildfire activity.

Prescribed burning includes removing portions of the litter on the forest floor and s understory vegetation, via the planned use of fire over part or all of a designated land area. Such burning is done under a "prescription" or a set of limits on burning conditions including temperature, wind, and fuel moisture in order to meet a set of predetermined objectives for the amount of litter and vegetation consumed (see Appendix A for the desired fire effects in each forest type). Several methods for the application of fire on the landscape are suggested, including, but not limited to: ground and aerial applications of fire through the use of handheld drip-torches, aerial ignition by spherical ignition devices or helitorch, fusees, flares or fire launchers, or propane torches.

Fire will mimic low to moderate severity fire effects in the coniferous forests and moderate to high severity fire effects in aspen that are typical of historic fire disturbances. Specific fire prescriptions will be determined by vegetation community type and are intended to move the treatment unit toward desired ecological conditions (Appendix A). Prescribed fire will not be implemented until fire behavior is anticipated to meet objectives. Test burns will be conducted, monitored, and reported to provide preliminary evaluations of fire behavior and effects. A prescribed burn will be terminated if the test burn or ongoing burning is not meeting the desired conditions (NWCG 2017).

In areas where specialists determine that fuel loading and/or stand structure is such that fire behavior might exceed acceptable thresholds and pose risk to prescriptive objectives and/or highly valued resources and assets (Wildland Urban Interface, infrastructure, sensitive biological or cultural resources, etc.), prescribed fire alone will not be the sole source of treatment. In these situations, hand thinning, limbing and/or targeted mowing will be used to reduce stand density

and ladder fuels and/or raise canopy base height (see below) prior to the prescribed fire. When pre-treatment field review indicates the most cost-effective method of reducing stand density is mechanical treatment (e.g., precommercial thinning with traditional logging equipment), separate site-specific projects will be planned under independent environmental review. If monitoring indicates natural regeneration is insufficient to sustain desired conditions for coniferous forest types in the analysis area, separate site-specific projects to improve early seral vegetation will be planned under independent environmental review.

Hand Thinning & Limbing Trees to Raise Canopy Base Height

Where undesirable fire effects are predicted due to stand conditions, hand thinning using chainsaws or other tools may occur prior to prescribed burning to reduce ladder fuels, canopy continuity and associated potential for crown fire initiation and spread. This action will be limited to coniferous vegetation types and is not proposed for aspen stands where crown fire may be desirable. Hand thinning will be used to increase tree spacing and to raise canopy base height of individual trees prior to initiating prescribed fire. Resulting materials will be scattered or left in place to assist understory fire spread where surface fuel arrangement is likely to result in consumption of the largest materials (1,000 hour fuels; Rebain 2010). When prescribed fire is unlikely to consume most residual materials, some or all of thinned vegetation will be piled and burned onsite. Saplings and pole sized trees growing within 15 feet of the dripline of legacy trees (the largest trees in stands or those greater than 30 inches DBH) will be cut to reduce potential fire spread from surface to crown. All thinning and limbing trees to raise canopy base height will occur in the project area according to applicable design features to allow prescribed fire to move treatment areas toward the desired conditions applicable to the relevant vegetation type for the area (Appendix A).

Targeted Mowing

Targeted mowing is proposed in coniferous vegetation with a heavy shrub layer and low canopy base heights prior to initiating prescribed fire. Low ground pressure equipment will be used. Chips will remain onsite, with an average depth less than 2 inches. The height of mowing will be controlled to leave a percentage of existing shrub cover determined through an interdisciplinary process that is being developed as a component of the implementation plan. Mosaic patterns, islands of untreated vegetation, unit boundaries that follow natural features, and irregular wavy edges will be used wherever possible to minimize effects to visual quality and promote vegetation structural heterogeneity.

Prescribed Fire Control Line Construction

Fireline construction will be used for the protection of cultural sites, sensitive resources, administrative sites, infrastructure or private property, and other features, as needed. Existing features such as roads, trails, or wet drainages will be used for fire control lines where possible. Where existing control lines are absent, firelines will be constructed to facilitate broadcast burning and hand piling burning operations. Fireline may be constructed by hand or mechanical methods. The amount of fireline construction will vary depending on the size of the burn area and existing conditions. See Table 1 for more specific descriptions of construction methods.

Cut material may be piled and burned or scattered. Firelines will be rehabilitated in locations where it is necessary to protect natural and cultural resources and scenic quality. Rehabilitation methods may include pulling removed material back into the lines, hand constructing water bars, or covering firelines with slash following burning completion. In other areas, firelines may be left in place for use in future prescribed fire.

The location of firelines will be approved based on required survey data and interdisciplinary review as developed in the implementation plan.

To ensure firefighter safety during prescribed burning, overhead hazard mitigations may be required. Overhead hazards (i.e. unsound snags) will be removed to a degree reasonably sufficient to exclude the possibility of a snag falling where people might be expected to spend appreciable time. In areas where overhead risk cannot be mitigated by any means (assessed and deemed unsafe/unable to fall or necessary to retain for resource protection, e.g. wildlife habitat), ignition patterns will be adjusted such that overhead risk is mitigated through avoidance.

Table 1. Fireline construction methods, ground disturbance, and safety measures.

Line Control Technique	Construction Methods	Limitations	Ground Disturbance	Safety Measures
Natural Barriers (e.g. green meadows, rock outcroppings, scree slopes, granite shields, rivers, large bodies of water)	None	Unit size may need to be reduced or expanded based on availability or adjacency of natural barriers	N/A	Limited hand falling of overhead hazards (i.e. unsound snags) to a degree reasonably sufficient to exclude the possibility of a snag falling where resources might be expected to spend appreciable time.
Existing Barriers (e.g. roads, previous recent prescribed burn units)	None	Unit size may need to be reduced or expanded based on availability or adjacency of existing barriers	N/A	Limited to some hand falling of overhead hazards (i.e. unsound snags) to a degree reasonably sufficient to exclude the possibility of a snag falling where resources might be expected to spend appreciable time. Where specific overhead hazards are assessed and deemed unsafe to fall by hand, equipment may be utilized to mitigate hazard (e.g. feller-buncher to lay trees over and/or dozer and/or excavator to push trees over and skidders). Consider blasting snags.
Handline Construction	Handcrews using hand tools, brushing with chainsaws, removal of dead and down logs in path of hand line	Production rates are slower than other line construction techniques	Approximately 3-foot-wide scrape down to mineral soil and associated brushing of handline commensurate with expected fire behavior adjacent to constructed line. Width of mineral scrape is dictated by fuel loading adjacent to hand line.	Remove all overhead hazards (i.e. unsound snags) that threaten falling on hand line where Rx fire lighting and holding resources will be expected to maintain patrol on foot during and after ignition. In areas where overhead risk cannot be mitigated by hand falling (assessed and deemed unsafe to fall by hand), and equipment is not feasible, line location will be such that overhead risk is avoided and/or located where mitigation can be conducted. Consider blasting snags.
Fireline Explosives	Blasting, followed by handcrews using hand tools, brushing with chainsaws, removal of dead and down logs in path of hand line	Contingent on availability of qualified blasters.	Approximately 3-foot-wide scrape down to mineral soil and associated brushing of handline commensurate with expected fire behavior adjacent to constructed line. Width of mineral scrape is dictated by fuel loading adjacent to hand line.	Remove all overhead hazards (i.e. unsound snags) that threaten falling on hand line where Rx fire lighting and holding resources will be expected to maintain patrol on foot during and after ignition. In areas where overhead risk cannot be mitigated by hand falling (assessed and deemed unsafe to fall by hand), and equipment is not feasible, line location will be such that overhead risk is avoided and/or located where mitigation can be conducted. Consider blasting snags

Line Control Technique	Construction Methods	Limitations	Ground Disturbance	Safety Measures
Mechanical Line Construction	Dozer, mowing, excavator, feller-buncher, skidder, brushing with chainsaws, light hand tool touch-up and windrowing by handcrews.	Costs are generally higher than other line construction methods.	Up to 8-foot-wide scrape down to mineral soil and associated brushing of mechanical line commensurate with expected fire behavior adjacent to constructed line. Width of mineral scrape is dictated by fuel loading adjacent to hand line.	Remove all overhead hazards (i.e. unsound snags) that threaten falling on hand line where Rx fire lighting and holding resources will be expected to maintain patrol on foot during and after ignition. In areas where overhead risk cannot be mitigated by hand falling (assessed and deemed unsafe to fall by hand), and equipment is not feasible, line location will be such that overhead risk is avoided and/or located where mitigation can be conducted. Consider blasting snags

SCOPING PROCESS

Public participation is important at numerous points during project planning and analysis. The scoping intent is to share our initial proposal and seek information, comments, and assistance from federal, state, and local agencies and individuals or organizations that may be interested in or affected by the proposed action. To accomplish this intent, we request your input and comments be submitted prior to **January 6, 2019**. Although you are encouraged to submit comments at any point during the planning process, input received prior to this date will be most useful for us to consider your comments and suggestions during project planning and analysis.

HOW TO COMMENT

Comments may be mailed to the Inyo National Forest, Attn: **Eastern Sierra Fire Project**, 351 Pacu Lane, Suite 200, Bishop CA 93514. Please submit electronic comments on the project website, at: https://www.fs.usda.gov/project/?project=56291. On the right side of that website, click on "Comment/Object on Project" in the "Get Connected" box. You can type your comment directly in the website or attach an electronic file. Names and addresses of those who comment will be considered part of the public record on this proposed action and will be available for public inspection. **Please submit comments prior to January 6, 2020**.

INFORMATION CONTACT

For additional information regarding this project, contact Inyo National Forest 351 Pacu Lane, Suite 200, Bishop CA 93514 or call (760)873-2449.

APPENDIX A: DESIRED CONDITIONS AND ACTIONS BY VEGETATION TYPE

JEFFERY PINE AND MIXED CONIFER FOREST

To restore natural fire frequency, prescribed fire will occur in Jeffery pine and mixed conifer vegetation types at an average fire return interval of 5 to 20 years. Mixed conifer vegetation is dominated by Jeffery pine, with varying amounts of lodgepole pine, white fir, red fir and, on the Kern Plateau, some ponderosa pine and sugar pine. Because Jeffery pine and mixed conifer vegetation types occur along an elevation gradient, generally lower elevation drier sites will be less dense with less fuel loading, while higher elevation wetter forests will be denser with higher fuel loads. These denser stands support fuel amount and arrangement capable of carrying fire on a higher frequency than lower productivity sites characteristic of lower elevations. All stands may be exposed to prescribed broadcast burning more than once during the life of the project to maintain fire frequency.

Jeffery pine and mixed conifer vegetation types are in Fire Regime Group I (Barrett et al. 2010, Heinselman 1973), with most fires having low severity effects to the dominant overstory (canopy). Low severity fire regimes do not imply lack of tree mortality or canopy consumption, but a fine mosaic of high severity patches of varying size (Table A1.). Less than 25 percent of overstory in these vegetation types will be consumed or killed within treated landscapes following application of prescribed fire. Patches of high severity are expected on high productivity sites or stands where height to live crown and tree spacing is low, allowing fire to spread from the ground to canopy and from crown to crown. On average, it is desirable for patches of 75 percent overstory mortality to occur across an average of 1 to 15 percent of the treated landscape (Minnich et al. 2000, Safford and Stevens 2017, vanWagtendonk and Lutz 2007). A mix of high severity patch sizes are desirable: high severity patch size of 1 acre or less frequently occur on average; 2 to 10 acre high severity patches will occasionally occur; and rarely will high severity patches reach 50 to 200 acres. High severity patches, where more than 75 percent of the dominant overstory is killed or consumed by fire, are desirable effects of the project when these patches burn within the natural range of variation and support desired vegetation conditions. For example, the largest high severity patches (50 to 200 acres) may not be considered desirable if they conflict with terrestrial ecosystem desired conditions (e.g., wildlife habitat and carbon carrying capacity). Safford and Stevens (2017) describe high severity patch size distribution in the context of natural range of variation for Jeffery pine and mixed conifer vegetation, and it is our intent to largely mimic these patterns through implementation of this project:

> The Inyo National Forest desires Jeffery pine and mixed conifer vegetation types exposed to prescribed fire in this project to be *strongly dominated by a "salt-and-pepper" pattern of* high severity fire, where *small* stand-replacing *areas* are *mostly (much) less than* 5 acres *in size. Patches larger than* 5 acres may occur, but they will be rare, relatively unusual, and not exceed 200 acres in size. These larger patches will comprise at least half the total high severity area when they occur *(*Safford and Stevens 2017).

Table A1. Maximum percent of high severity patches desired conditions for Jeffery pine, mixed conifer, red fir, and lodgepole pine vegetation across the landscape. High severity patches are those where 75 percent or more of the dominant overstory is killed or consumed by fire.

High severity patch size (acres)	**Frequency of patches across the forest landscape (proportion)**
Small (≤1 acre)	Frequent (>60%)
Medium (2-10 acres)	Infrequent (<30%)
Large (11-50 acres)	Uncommon (<10%)
Very large (50-200 acres) [1]	Rare (<1)

[1]Very large high severity patches are not considered desirable if they conflict with other forest plan desired conditions.

LODGEPOLE PINE AND RED FIR FORESTS

Dry and wet lodgepole pine occur within the planning area and are highly variable across the Inyo National Forest based on topographic position, slope (steepness), soil nutrient and moisture availability and a mixed fire regime. Historical fire return intervals generally range from 20 to over 100 years in lodgepole pine stands. Similar to lodgepole pine, red fir stands are variable across the planning area, stand density is largely driven by aspect, moisture availability and elevation. Due to this variation in stand conditions, historical fire return intervals in red fir stands range widely from 15 to 80 years, but mostly occurred every 20 to 40 years in the planning area. Prescribed fire would reestablish or maintain the natural fire regime within lodgepole pine and red fir ecosystems (Meyer and North 2019).

Lodgepole pine and red fir vegetation types are in Fire Regime Group III (Barrett et al. 2010, Heinselman 1973), with generally mixed severity effects to the dominant overstory (canopy). Most stands proposed for treatment will have low to moderate severity fire effects, with occasional occurrence of higher proportion of canopy consumption and mortality. On average, it is desirable for high severity fire (areas with more than 75 percent overstory mortality) to occur across an average of 5 to 20 percent of the burned area in these vegetation types, with lower percent values in red fir (5 to 15 percent) compared to lodgepole pine (5 to 20 percent).

ASPEN

The life cycle of aspen is closely linked to fire, where higher intensity fire is needed to consume the bulk of the canopy to trigger hormonal suckering response and regenerate stands through aspen seedling establishment. Fire return interval of 10 to 90 years with mixed to high severity fire effects were historically characteristic of this vegetation type. On average, it is desirable for mixed severity fire effects (i.e., combination of low, moderate, and high severity fire) to occur across aspen stands every 10 to 20 years and high severity fire effects (stand replacing) every 60 or more years (Estes 2013). Sierra Nevada aspen stands treated with prescribed burning or exposed to wildfire exhibit increased aspen sprout density and growth rates and greater seedling densities in response to mixed severity fire. These patterns are especially apparent in burned aspen stands that lack substantial, pre-fire coarse woody debris and heavy post-fire ungulate browsing pressure (Krasnow and Stephens 2015).

FIRE RETURN INTERVALS PROJECT WIDE

Using the historical fire return intervals described above for each of the target vegetation types, and the median historical fire return interval in the Forest Service Fire Return Interval Departure (FRID) database, we calculated the area of fire that would be needed across the project area to maintain natural fire regimes. These numbers are based on the current best available science and would be modified if further science refines our understanding of fire regimes especially in the unique environment of the eastern Sierra and the Glass Mountains.

Table A2. Approximate acres of fire in each forest type in the project area based on median fire return interval. *Decadal fire acreage under natural fire regime* reflects total amount of acres burned within a 10-year period for target vegetation types described above.

Fire Return Interval (FRI) group	Median FRI	Acres in the Project Area	Decadal Fire Acreage Under Natural Fire Regime
10 to 90 years	40	10,270	2,570
20 to 40 years	30	30,590	10,200
5 to 20 years	13	163,910	126,100
TOTAL		**204,770**	**138,870**

APPENDIX B: REFERENCES

Barrett, S., D. Havlina, J. Jones, W. Hann, C. Frame, D. Hamilton, K. Schon, T. Demeo, L. Hutter, J. Menakis. 2010. Interagency fire regime condition class guidebook. Last updated September 2010: Version 3.0. In: Interagency fire regime condition class website. USDA, Forest Service; U.S. DOI; The Nature Conservancy and Systems for Environmental Management. Available: https://www.landfire.gov/frcc/documents/FRCC_Guidebook_2010_final.pdf [2019, July 1].

Estes, B. 2013. Historic range of variation for aspen in the Sierra Nevada and Southern Cascades. Unpublished report. United States Department of Agriculture, Forest Service, Pacific Southwest Region. Vallejo, CA. 44 pp. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5434340.pdf

Heinselman, M. 1973. Fire in the virgin forests of the Boundary Waters Canoe Area, Minnesota. Quaternary Research. 3(3): 329-382.

Krasnow, K. D., S. L. Stephens. 2015. Evolving paradigms of aspen ecology and management: impacts of stand condition and fire severity on vegetation dynamics. Ecosphere 6(1):12.

Meyer, M.D., M.P. North. 2019. Natural range of variation of red fir and subalpine forests in the Sierra Nevada bioregion. PSW-GTR-263. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. 135 p.

Meyer, M., A. Wuenschel, M. Slaton. 2018. Indiana Summit Research Natural Area draft post-fire ecological assessment. Unpublished report. United States Department of Agriculture, Forest Service, Pacific Southwest Region. Bishop, CA.

Minnich, R.A., M.G. Barbour. J.H. Burk, J. Sosa-Ramìrez. 2000. Californian mixed conifer forests under unmanaged fire regimes in the Sierra San Pedro Màrtir, Baja California, Mexico. Journal of Biogeograpghy 27: 105-129.

National Wildfire Coordinating Group (NWCG). 2017. Interagency Prescribed Fire Planning and Implementation Procedures Guide. U.S. Department of Agriculture and U.S. Department of the Interior, NWCG, Idaho, Boise. 57 p.

North, M., P. Stine, K. O'Hara, W. Zielinski, S. Stephens. 2009. An ecosystem management strategy for Sierran mixed-conifer forests. General Technical Report. PSW-GTR-220. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 49 p.

North, M., ed. 2012. Managing Sierra Nevada forests. General Technical Report. PSW-GTR-237. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 184 p.

Rebain, S., comp. 2010 (revised March 23, 2015). The Fire and Fuels Extension to the Forest Vegetation Simulator: Updated Model Documentation. Internal Report. Fort Collins, CO: U.S. Department of Agriculture, Forest Management, Forest Management Service Center. 403 p.

Safford, H., J. Stevens. 2017. Natural range of variation for yellow pine and mixed conifer forests in the Sierra Nevada, southern Cascades, and Modoc and Inyo National Forests,

California, USA. PSW-GTR-256. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. 229 p.

Shive, K., H. Preisler, K. Welch, H. Safford, R. Butz, K. O'Hara, S. Stephens. 2018. From the stand scale to the landscape scale: predicting spatial patterns of forest regeneration after disturbance. Ecological Applications 28: 1626–1639.

van Wagtendonk, J.W., J. Lutz. 2007. Fire regime attributes of wildland fi res in Yosemite National Park, USA. Fire Ecology 3(2): 34-52.

Welch, K., H. Safford, T. Young. 2016. Predicting conifer establishment post wildfire in mixed conifer forests of the North American Mediterranean-climate zone. Ecosphere 7:e01609.